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The effects of the association with eelgrass on the embryonic development of the gastropod *Haminoea vesicula* (Gould, 1855)

Marine gastropods commonly deposit egg masses in association with photosynthetic organisms. The gastropod *Haminoea vesicula* attaches its egg ribbons to the eelgrass *Zostera marina*. Photosynthesis by such macrophyte can provide significant amounts of oxygen to embryos throughout the egg ribbon. Little is known, however, about the actual benefits or costs to embryonic development of this intimate association. I examined the effects of the association between *H. vesicula* egg ribbons and the eelgrass *Z. marina* on developmental rate and larval shell length. Pieces of *Haminoea vesicula* egg ribbon were pinned into mesh-bottom plastic trays. Half of the egg mass pieces were pinned onto *Z. marina* blades. Embryos were placed in outdoor tanks with flowing seawater and raised under five different light conditions: 0%, 25%, 50%, 75% and 100% blocked sunlight. Embryos attached to eelgrass developed significantly faster under good light conditions, whereas, under poor light conditions, the association with *Z. marina* significantly increased development time. Under moderate light levels (25% - 50% blocked sunlight), development of *H. vesicula* was faster whether embryos were attached or not to the macrophyte. A significant decline in newly-hatched larvae shell length was observed at low light levels. The association with eelgrass did not affect larval hatching size.

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Chemical Communication, Keystone Molecules, and Forces Structuring Natural Communities

Sensory systems provide critical filters that enable organisms to detect and recognize valuable resources. Trophic cascades, structuring populations and communities, are largely determined by trait-mediated interactions that rely on sensory inputs. Certain molecules, serving as chemical signals, can establish the course of community dynamics at multiple trophic levels. Here, we investigated the roles of surface-adsorbed proteins in mediating predator-prey dynamics on wave-swept shores. For cuticle/shell formation, barnacles (*Balanus glandula*) are required to produce a high molecular weight, insoluble, glycoprotein complex. A primary subunit (~98 kDa) of this protein complex was isolated, purified, and, in field tests, evoked settlement by conspecific larvae. The subunit thereby operates as a seminal recruitment cue. Moreover, the same compound triggered a predatory response in numerically dominant whelk species distributed throughout the eastern Pacific (*Acanthinucella spirata*, *Nucella emarginata*, *N. ostrina*, *N. canaliculata*, *N. lamellosa*). Such proteins, therefore, simultaneously influence demographic processes that enhance or diminish barnacle populations. As dominant competitors for space, the relative balance between barnacle recruitment and predation mortality has strong direct and indirect effects which influence community dynamics. Furthermore, the ability of all whelks to detect and respond to these signals suggests that the biogeography of barnacles, and their population stability, is affected in comparable ways. The conserved response of many species to the same signal, and the resultant cascading effects across multiple trophic levels, signify barnacle glycoproteins as keystone molecules that structure communities on wave-swept shores.

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Community ecology, evolution, and molecules of keystone significance

The keystone species concept is seminal in ecological theory. It involves species whose impacts on communities are far greater than would be predicted from their relative abundances or biomasses. Similarly, select neuroactive compounds function in keystone roles. They are rare within natural habitats but connect such seemingly disparate processes as microbial loop dynamics and apex predation. Outstanding examples draw on four distinct sets of compounds: dimethylsulfoniopropionate (DMSP and metabolites), tetrodotoxin (TTX and its precursor, arginine), saxitoxin (STX), and pyrrolizidine alkaloids (PAs). Introduced into a respective community by one, or only a few, autotrophic or microbial species, these molecules originally function in chemical defense. When borrowed by resistant consumer species, however, they are used either in chemical defense against higher-order predators, or as chemosensory cues that elicit courtship and mating, alarm, and predatory search. Requisite to these multifunctional properties, biosynthetic capacity first evolves with mechanisms for autoimmunity and/or toxin storage in primary producers. Subsequently, consumers evolve resistances or tolerances, and the toxins are transferred through food webs via trophic interactions. In consumers, mechanisms develop for recognizing toxins as feeding cues, and eventually as signals or pheromones in chemical communication within, or between, species. Through convergent evolution, one, or a few, neuroactive compounds thus inform phylogenetically diverse species in a given community. These select molecules initiate major direct and indirect effects, causing potent reverberations and structuring respective communities within terrestrial, freshwater, coastal-ocean and open-ocean habitats.

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Prey processing in chimaeroid fishes

Holocephalans are uniquely derived for durophagy: the upper jaw is fused to the neurocranium (holostyly), and all chimaeriform holocephalans, extinct and extant, possess tooth plates. Yet, for the three extant families, authors have posited that there has been a gradual transition away from a reliance on crushing benthic prey. The Callorhynchidae (*Callorhynchus*) are the most like ancestral chimaeriforms in their morphology. However, the Chimaeridae (*Hydrolagus* and *Chimaera*) are described as being less suited for crushing, and more reliant on suction prey capture. We set out to quantify differences in morphology and performance between these two chimaeriform groups, and specifically to test the hypothesis that *Callorhynchus* is capable of processing harder prey than *Hydrolagus* or *Chimaera*. Cranial and muscular data were collected from a size range (~10 individuals) of *Callorhynchus callorhynchus*, *Hydrolagus collieri*, and *Chimaera monstrosa*. A PCA on external head measurements suggested that there are differences in head shape, but contrary to predictions, *Chimaera* was different from *Callorhynchus* and *Hydrolagus*. However, MANCOVA, used to compare estimated bite forces among the three species, with head width as a covariate, revealed that *Callorhynchus* tended to differ from *Hydrolagus* and *Chimaera*. Additional statistical exploration of the cranial and muscular variables used to generate bite force estimates further supported such performance differences. Interestingly, CT scans of *Callorhynchus* and *Hydrolagus* revealed only subtle differences in the amount of skeletal calcification (reinforcement), which was slight in both species. Further, *Callorhynchus* appears to possess some red adductor musculature, which, if confirmed, yields significantly lower bite force estimates. Thusly, it remains unclear if the chimaeroid feeding paradigm is supported.